PATENT CLAIMS

1. A composite metal product, characterized in that it contains 30-90 vol-% of a hard phase in the form of particles of substantially M(C,N)-carbonitride or M(C,N,O)-carbonitrideoxide, commonly referred to as hard phase of MX-type, where M to at least 50 atomic-% consists of titanium, which particles are essentially homogenously distributed in a matrix consisting of a hardenable steel, and that the atomic-% ratio between C and N shall satisfy the condition $0.1 < \frac{N}{C+N} < 0.7$.

2. A product according to claim 1, characterized in that the atomic-% ratio between C and N shall satisfy the condition $0.2 < \frac{N}{C+N} < 0.6$.

3. A product according to claim 2, characterized in that the atomic-% ratio between C and N shall satisfy the condition $0.3 < \frac{N}{C+N} < 0.6$.

4. A product according to claim 3, characterized in that the atomic-% ratio between C and N shall satisfy the condition $0.4 < \frac{N}{C+N} < 0.5$.

5. A product according to any of claims 1-4, characterized in that 90 % of the number of said hard phase particles has a size, the longest extension of which is smaller than 1 μm in a view section of the product.

6. A product according to any of claims 1-5, characterized in that not more than 10 % of a section of the product consists of regions having a length of at least 6 **d** in the direction of the longest extension of the region, a width crosswise said direction of longest extension, in any section of the region, of at least 6 **d**, and an area of at least $9\pi \mathbf{d}^2$ where **d** is the mean value of the size of the hard phase particles of MX-type in the longest extension of the particles in the observed section, which regions are void of hard phase particles of MX-type.

7. A product according to any of claims 1-6, characterized in that not more than 0.5 % of a section of the product consists of regions having a length of at least 8 μm in the direction of the longest extension of the region, a width crosswise said direction of longest extension, in any section of the region, of not more than 8 μm,

and an area of at least 50 μm^2, which regions are void of hard phase particles of MX-type.

8. A product according to claim 1, c h a r a c t e r i z e d in that M in said hard phase to at least 70 atomic-% consists of titanium.

9. A product according to claim 8, c h a r a c t e r i z e d in that M in said hard phase to at least 80 atomic-% consists of titanium.

10. A product according to claim 9, c h a r a c t e r i z e d in that M in said hard phase to at least 90 atomic-% consists of titanium.

11. A product according to any of claims 1-10, c h a r a c t e r i z e d in that max. 40 atomic-% of M in said hard phase of MX-type consists of (V+Nb).

12. A product according to claim 11, c h a r a c t e r i z e d in that max. 30 atomic-% of M in said hard phase consists of or more of the metals which belong to the group consisting of V, Nb, Ta, Hf and Zr.

13. A product according to claim 11 or 12, c h a r a c t e r i z e d in that max. 25 atomic-% of M in said hard phase consists of Nb.

14. A product according to claim 13, c h a r a c t e r i z e d in that max. 15 atomic-% of M in said hard phase consists of Nb.

15. A product according to any of claims 1-14, c h a r a c t e r i z e d in that at least 2 atomic-% of M in said hard phase consists of V.

16. A product according to claim 15, c h a r a c t e r i z e d in that at least 5 atomic-% of M in said hard phase consists of V.

17. A product according to claim 15 or 16, c h a r a c t e r i z e d in that max. 15 atomic-% of M in said hard phase consists of V.

18. A product according to any of claims 1-17, c h a r a c t e r i z e d in that at least 2 atomic-% of M in said hard phase consists of Nb.

19. A product according to claim 18, characterized in that at least 5 atomic-% of M in said hard phase consist of Nb.

20. A product according to any of claims 1-19, characterized in that max. 3 atomic-% of M in said hard phase consists of Ta, max. 3 atomic-% of Zr, and max. 3 atomic-% of Hf.

21. A product according to claim 20, characterized in that said hard phase of MX-type does not contain Ta, Zr or Hf at levels exceeding impurity levels.

22. A product according to any of claims 1-21, characterized in that it contains 30-70 vol-% of said hard phase of MX-type.

23. A product according to claim 22, characterized in that it contains 40-60 vol-% of said hard phase of MX-type.

24. A product according to any of claims 1-23, characterized in that said hard phase of MX-type contains oxygen in an amount of 0.01-4 atomic-% of the total content of C+N+O in said hard phase.

25. A product according to any of claims 1-24, characterized in that said matrix including secondarily precipitated MC-carbides, which may exist in the matrix, and any hard phase of other type than MX-type, which may exist in the matrix, has the following chemical composition in weight-%:

0.3-3.0 C
from traces to max. 2 Si
from traces to max. 2 Mn
from traces to max. 0.5 S
2-13 Cr
from traces to max. 18 W
from traces to max. 12 Mo
from traces to max. 15 Co
from traces to max. 10 V
from traces to max. 2 Nb
balance Fe, however at least 50 weight-% Fe, and normally existing impurities from the manufacturing of the steel.

26. A product according to claim 25, characterized in that the matrix contains max. 2 weight-% Nb.

27. A product according to claim 25 or 26, characterized in that said matrix, including any secondarily precipitated MC-carbides and any hard phase of other type than MX-type, which may exist in the matrix, has a chemical composition which contains max. 1 weight-% Si and 3-10 weight-% Cr.

28. A product according to claim 27, characterized in that the content of (W+Mo+V) in said matrix, including any secondarily precipitated MC-carbides and any hard phase of other type than MX-type, which may exist in the matrix, amounts to at least 10 weight-%.

29. A product according to claim 27, characterized in that the content of (W+Mo+V) in said matrix, including any secondarily precipitated MC-carbides and any hard phase of other type than MX-type, which may exist in the matrix, amounts to max. 10 weight-%.

30. A product according to claim 28, characterized in that said matrix, including any secondarily precipitated MC-carbides and any hard phase of other type than MX-type, which may exist in the matrix, has a chemical composition, which contains, in weight-%, 3-7 Cr and 10-20 (W+Mo+V).

31. A product according to claim 29, characterized in that said matrix, including any secondarily precipitated MC-carbides and any hard phase of other type than MX-type, which may exist in the matrix, has a chemical composition, which contains, in weight-%, 2-7Cr and 5-10 (W+Mo+V).

32. A method for manufacturing a composite metal product which contains 30-90 vol-% of a hard phase having the form of particles, which consist mainly of M(C,N)-carbonitride or M(C,N,O)-carbonitrideoxide, commonly referred to as hard phase of MX-type, which particles are substantially homogenously distributed in a matrix of hardenable steel, characterized in that a powder mixture, which contains powder of titanium carbide, titanium nitride, and/or titanium carbonitride in such amount that its content of titanium atoms correspond to at least 50 % of the metal atoms in said hard phase of MX-type in the final metal product, and at least the main part of other constituents of the final metal product, is milled together, that a body is

formed of the milled mixture, and that said body is liquid phase sintered at a temperature between 1350 and 1600 °C and subsequently cooled, causing the liquid phase to solidify, said hard phase particles of MX-type obtaining their final composition and size during said liquid phase sintering and subsequent solidification.

33. A method according to claim 32, characterized in that the contents of carbon and nitrogen are controlled during the integrated process, which comprises selection and mixing of powders, milling the powder mixture, forming a green body of the milled powder mixture, and liquid phase sintering the green body, such that the contents of carbon and nitrogen of said hard phase of the final product, expressed in atomic-%, satisfy the ratio $0.1 < \frac{N}{C+N} < 0.7$.

34. A method according to claim 33, characterized in that the contents of carbon and nitrogen are controlled during the integrated process, which comprises selection and mixing of powders, milling the powder mixture, forming a green body of the milled powder mixture, and liquid phase sintering the green body, such that the contents of carbon and nitrogen of said hard phase of the final product, expressed in atomic-%, satisfy the ratio $0.2 < \frac{N}{C+N} < 0.6$.

35. A method according to claim 34, characterized in that the contents of carbon and nitrogen are controlled during the integrated process, which comprises selection and mixing of powders, milling the powder mixture, forming a green body of the milled powder mixture, and liquid phase sintering the green body, such that the contents of carbon and nitrogen of said hard phase of the final product, expressed in atomic-%, satisfy the ratio $0.3 < \frac{N}{C+N} < 0.6$.

36. A method according to claim 35, characterized in that the contents of carbon and nitrogen are controlled during the integrated process, which comprises selection and mixing of powders, milling the powder mixture, forming a green body of the milled powder mixture, and liquid phase sintering the green body, such that the contents of carbon and nitrogen of said hard phase of the final product, expressed in atomic-%, satisfy the ratio $0.4 < \frac{N}{C+N} < 0.5$.

37. A method according to any of claims 32-36, characterized in that the milling of the powder mixture is carried out with a supply of energy of at least 10 MJ (megajoule)/kg powder.

38. A method according to claim 37, characterized in that the milling of the powder mixture is carried out with a supply of energy of at least 20 MJ /kg powder.

39. A method according to claim 37 or 38, characterized in that the milling of the powder mixture is carried out with a supply of energy 10-50 MJ /kg powder.

40. A method according to any of claims 32-39, characterized in that the content of oxygen is controlled during said integrated process such that the content of oxygen in the final product amounts to 0.01-4 atomic-% counted on the total content of C+N+O in the hard phase.

41. A method according to any of claims 32-40, characterized in that the liquid phase sintering is carried out at a temperature of 1450-1510 °C during a holding time of between 10 minutes and 2 hours at the sintering temperature, preferably during a holding time of 10-60 minutes.